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PRINCIPAL SOURCES AND DISPERSAL PATTERNS OF SUSPENDED PARTICULATE  
MATTER IN NEARSHORE SURFACE WATERS OF THE NORTHEAST PACIFIC OCEAN  
AND THE HAWAIIAN ISLANDS /

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## Type I Progress Report

### ERTS-1

- a. PRINCIPAL SOURCES AND DISPERSAL PATTERNS OF SUSPENDED PARTICULATE MATTER IN NEARSHORE SURFACE WATERS OF THE NORTHEAST PACIFIC OCEAN AND THE HAWAIIAN ISLANDS.

ERTS-1 Proposal No.: SR209

Subdisciplines: 5B, F, H

- b. GSFC ID No. of P. I.: IN 011
- c. Statement and explanation of any problems that are impeding the progress of the investigation:

During this report period we were plagued by an ongoing problem: much of the nearshore zone was part<sup>ly</sup> or completely obscured by clouds. On two attempts to obtain "water truth", in the Gulf of the Farallones, coincident with a satellite pass, clouds moved into the area of interest less than an hour before the satellite was scheduled to obtain imagery. By the time the satellite was overhead, the area was totally covered by clouds. In order to fulfill the objectives of our experiment we requested an extension of coverage through the fall season, hoping that this will permit more complete coverage of some of the more cloud-prone target areas.

- d. Discussion of the accomplishments during the reporting period and those planned for the next reporting period:

In conjunction with satellite passes of April 4 and 5, "water-truth" measurements were made from the R/V POLARIS and two small boats in south San Francisco Bay on April 4, and from the R/V POLARIS in the Gulf of the Farallones on April 5. Aerial observations of the bay and gulf

were also made on the latter date from a light plane. During this same week NASA Ames provided underflight coverage (U-2 aircraft) of San Francisco Bay and the northern and central California coast (April 3 and 4).

ERTS imagery (bands 4 & 5) of the San Francisco Bay system and adjacent ocean taken April 4, 1973 shows numerous boundary lines between masses of different colored water in the Gulf of the Farallones. Some of these boundaries are indistinct and can be traced only a short distance, but many are very clear and can be traced many kilometers (Fig. 1). U-2 aerial photographs taken April 3, 1973 can be used very advantageously to supplement the ERTS imagery of the following day (Fig. 2).

On April 5, 1973 near-surface water data were collected in the Gulf of the Farallones from the research vessel POLARIS. The variables measured included turbidity (measured with Secchi disc), transmissivity (measured with a one meter and a 0.1 meter beam path transmissometer) and weight of suspended sediment (vacuum filtered through 0.45 $\mu$  silver filters). These data are shown in the following table and the sample stations are indicated on figures 1 and 2.

Gulf of Farallones stations occupied April 5, 1973

Station	Time PST*	Light Transmission				Secchi Disc Visibility (meters)	Suspended Sediment (mg/liter)
		0.1 m. path		1 m. path			
		% T	$\alpha^{**}$	% T	$\alpha$		
A	0955 hrs	91	0.94			4.1	
B	1005	92	0.83			3.9	14.8
C	1023	92	0.83	27	1.31	4.0	10.8
D	1039	91	0.94	16	1.83	2.8	20.4
E	1100	92	0.83	16	1.83	2.8	23.6
F	1144	74	3.01	7	2.66	2.0	25.6
G	1204	65	4.31	6	2.81	1.5	27.5

\* subtract 50 min. for corresponding tidal time on 4/4/73.

\*\*  $\alpha$  is the volume attenuation coefficient for light.

Clouds make the satellite image of April 5, 1973 unusable, however, a correlation can be made between the above field data of April 5th and ERTS (4/4/73) and U-2 (4/3/73) imagery, particularly the green and red bands.

The most readily discernible mass of water is the plume of turbid water which can be traced about 20 km. west of the Golden Gate Bridge (Fig. 1). The near-surface water of the plume is considerably more turbid than the water northwest of the plume (compare samples F and G collected within the plume with the samples collected north and west of the plume - see table and fig. 1). The transmissivity of the plume water ranges from 65% - 75% compared to >90% outside the plume. Additional bands of suspended sediment can be identified seaward of the plume from the field data. Stations D and E located within an intermediate tonal band yielded Secchi disc depth values of 2.8 meters, compared to readings almost a meter less landward

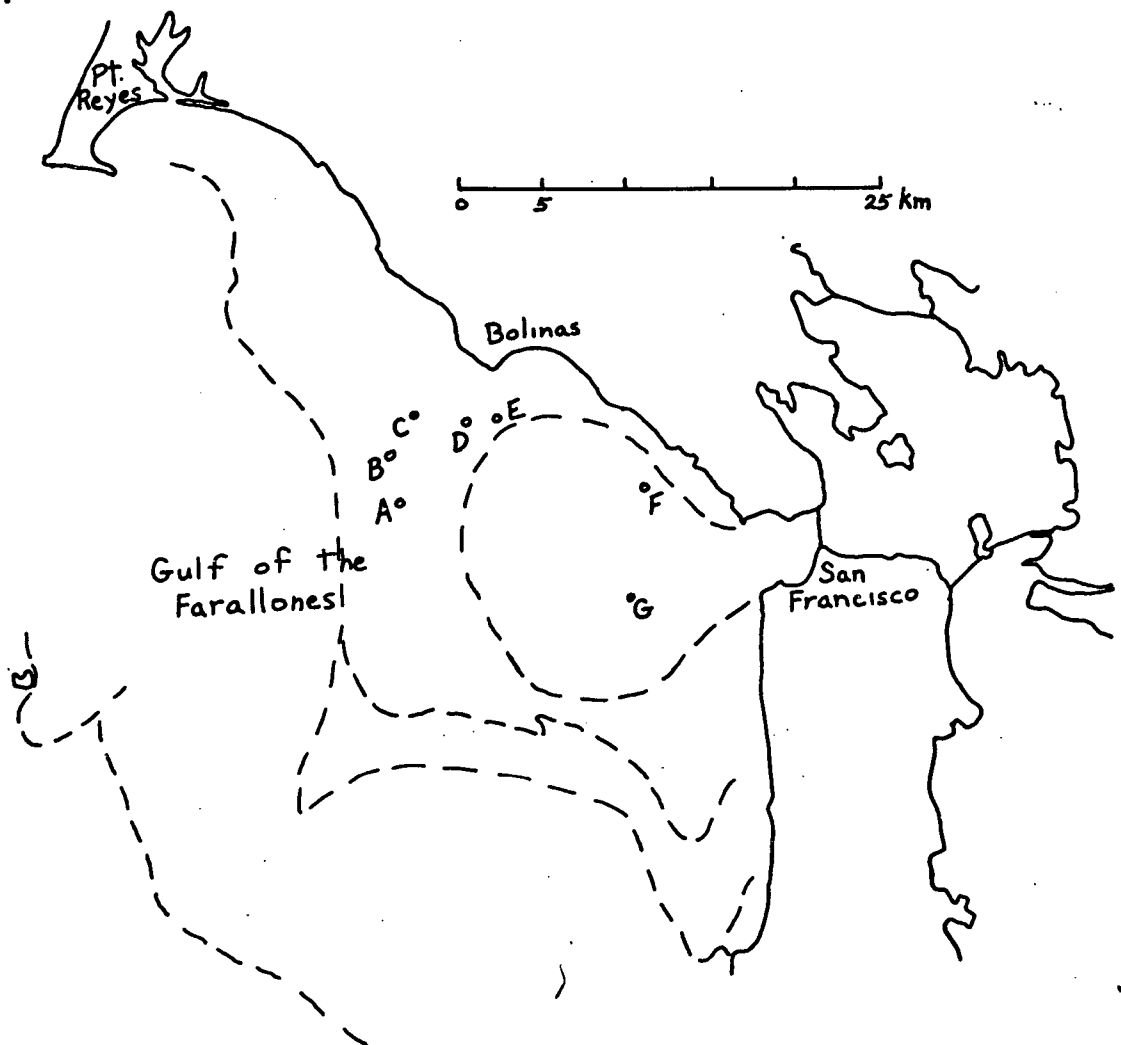


Figure 1. Boundaries of different masses of water in the Gulf of the Farallones visible on ERTS imagery of April 4, 1973. The dashed lines represent the tonal boundaries from the positive transparency. Letters A-G indicate water stations occupied April 5, 1973.

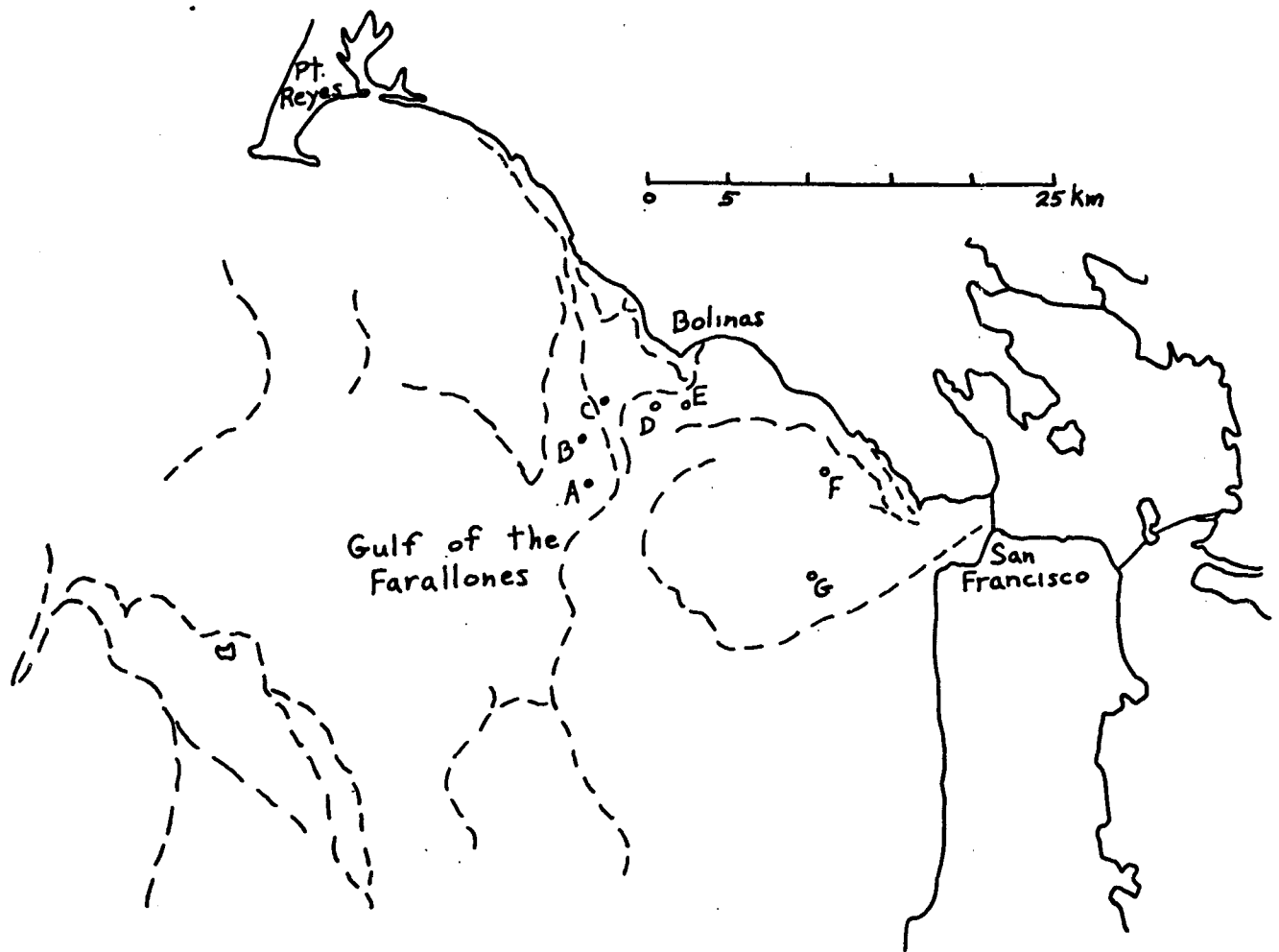


Figure 2. Boundaries of different masses of water in the Gulf of the Farallones visible on U-2 photographs taken April 3, 1973. The dashed lines represent the tonal boundaries from positive transparencies. Letters A-G indicate water stations occupied April 5, 1973.

(Sta. F & G) and a meter more seaward (Sta. A, B & C). It is difficult to determine the source of the suspended sediment seaward of the well-defined plume, however, some of the suspended matter appears to have originated in the nearshore zone between Pt. Reyes and Bolinas.

Based on the water patterns visible on the ERTS imagery and the high altitude photography, the movement of the surface water along the northern and central California coast during the 1st week of April 1973, seems to be toward the south. This flow direction relates well to the general southward flow of the off-shore water of the California Current at this time of the year and is the reverse of the surface current directions as observed on ERTS images of January, 1973 when the northward flowing Davidson Current was evident (Carlson et al., 1973).

In conjunction with mid-June satellite passes over the coastal zone of central and northern California, drift cards will be air-dropped off the mouths of the principal rivers. Data from these drop points will provide additional information about the dispersal of river-borne suspended particulate matter. These data also will be very useful when interpretations are being inferred from the ERTS imagery about flow directions of the near-surface longshore currents.

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Carlson, Paul R., Conomos, T. John, Janda, Richard J., and Peterson, David H., 1973. Principal sources and dispersal patterns of suspended particulate matter in nearshore surface waters of the northeast Pacific Ocean and the Hawaiian Islands. 2 April 73, 9 p., NASA-CR-131307, Natl. Tech. Info. Service E 73-10487.

Satellite imagery and U-2 photographs of the California coastal zone taken early in April 1973 show numerous plumes of suspended sediment being deflected southward. This indicates a southward flow of the nearshore, near-surface waters, a reversal from that noted in January 1973.

- f. A listing of published articles, and/or papers, pre-prints, in-house reports, abstracts of talks, that were released during the reporting period: NONE
- g. Recommendation concerning practical changes in operations, additional investigative effort, correlation of effort and/or results as resulted to a maximum utilization of the ERTS system: NONE
- h. A listing by date of any changes in Standing Order Forms: NONE
- i. ERTS Image Descriptor forms: NONE
- j. Listing by date of any changed Data Request forms submitted to Goddard Space Flight Center/NDPF during the reporting period: NONE
- k. Status of Data Collection Platforms (if applicable): N/A



Coincident with the June 15, 1973 satellite pass over San Francisco Bay, water samples and measurements will be obtained from the R/V POLARIS.

- e. Discussion of significant scientific results and their relationship to practical applications or operational problems including estimates of the cost benefits of any significant results (To be prepared in scientific abstract form of 200 words or less):

ERTS green and red band imagery supplemented by U-2 photographs provides synoptic views of turbid, nearshore, near-surface bodies of water which adds to the body of knowledge about the coastal ocean necessary for a thorough understanding of that dynamic environment.

Turbidity and suspended sediment measurements made in the Gulf of the Farallones correlate well with water tonal patterns visible on satellite imagery. Three successively seaward zones of turbid water could be delineated. Secchi disc visibility tests were the most definitive, ranging from  $\leq 2$  meters in the main plume, to almost 3 meters in the second zone of turbid water, to 4 meters in the furthest seaward zone of turbid water measured. These variations in water clarity were reinforced by suspended sediment concentrations which ranged from 26-28 mg/l, to 20-24 mg/l, to 11-15 mg/l, respectively, in each of the three masses of water. Transmissometer readings were basically in agreement with the suspended sediment and Secchi disc values measured.

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